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Characteristics of an African Easterly Wave Observed During NAMMA

R. Cifelli, T. Lang, S. A. Rutledge, and N. Guy
Colorado State University, Atmospheric Science, Fort Collins, United States (rob@atmos.colostate.edu)

The evolution of an African Easterly Wave (AEW) is described using ground based radar data from 3 distinct locations in West Africa: Niamey, Niger (continental), Dakar, Senegal (coastal), and Praia, Republic of Cape Verde (oceanic). The data were collected during the combined African Monsoon Multidisciplinary Analyses (AMMA) and NASA-AMMA (NAMMA) campaigns in August-September, 2006. The wave (hereafter referred to as Wave 5) was tracked using a combination of ECMWF analyses, upper air sounding, and METEOSAT outgoing longwave radiation (OLR) data. Lightning data from the World Wide Lightning Location Network (WWLLN), and satellite (TRMM) data were also used to explore the relationship between the large-scale features of the AEW and mesoscale convective systems (MCSs) observed by the ground-based radars and WWLLN.

OLR and ECMWF data showed that Wave 5 formed over the Joss plateau near 10°E on 30 August, 2006, passing through Niamey, Dakar, and Praia on 31 August, 2 September, and 3 September, respectively. Further tracking westward indicated that this wave likely interacted with a previous AEW disturbance near 55°W on 7 September and the combined complex became tropical storm Gordon on 11 September. Gordon later became the most intense Atlantic hurricane of the 2006 season.

During it's passage across west Africa, Wave 5 had a complicated structure with multiple vorticity centers. In particular, a vorticity center at 700 mb remained south of the African Easterly Jet (AEJ) and at least two low-level (925 mb) vorticity centers straddled the AEJ during the wave passage over west Africa. The precipitation in Wave 5 was primarily concentrated on the south side of the AEJ, in association with one of the low-level vorticity centers and the region where low-level moisture was concentrated. The low-level vorticity centers later merged after the AEW exited the west African coast.

The radar and lightning data indicated that precipitation characteristics associated with Wave 5 responded to changes in the large-scale environment as the wave traversed across west Africa and into the Atlantic. The convection at the coastal and continental sites was organized into squall line MCSs with leading line convection and trailing stratiform regions, due to the close proximity of the AEJ and resulting large shear near these radar locations. However, the intensity of convection at the continental site was relatively weak due to a combination of factors: the large-scale, low-level convergence associated with the wave was concentrated south of the radar domain; and, the environment sampled by the continental radar was relatively unfavorable (low CAPE) resulting from convective activity on the previous day.

As Wave 5 exited the coast, the AEJ shifted north and the shear was greatly reduced. Thus, the precipitation was relatively disorganized at the oceanic site with MCSs consisting of extensive stratiform echo and embedded convection. Interestingly, the radar and lightning data revealed that convective activity was primarily concentrated within the wave trough at the coastal and continental sites (east) and ahead of the AEW trough at the oceanic site (west), a trend opposite to a number of previous studies of AEW precipitation.

The precipitation activity was longer lasting at the oceanic site with slow build-up and decay phases compared to the coastal and continental sites. This was likely due to the merging of low-level vorticity centers over the ocean and reduction in phase speed of Wave 5 as it crossed the domain sampled by the radar in the Cape Verdes. Both of these factors provided a longer period of instability and favorable environment for convective activity at the oceanic site.